THE DEVELOPMENT OF INTERNET-BASED EXPERIMENT SYSTEM AND THE UTILIZATION OF PRACTICE TEACHING RESOURCES FOR CONTINUING ENGINEERING EDUCATION

Zheng Yanfen, Yuan Fang, Zhu Shanan

Administration of Continuing Education, Zhejiang University,
Hangzhou, China
zhengyf@zju.edu.cn

ABSTRACT: *In the perspective that practice teaching resources is urgent to be extended for continuing engineering education, this paper analyzes several problematic issues in the development of advanced engineering education in China. It introduces the development and utilization of the internet-based experimental system at Zhejiang University as one possible solution, and discusses the feasibility of similar experimental system development in other academic fields. Finally, it demonstrates that more efforts need to be exerted into internet-based experiment system development so that engineering continuing education would get progress rapidly.*

KEYWORDS: *Internet-based Experiment System; Continuing Engineering Education; Practice Teaching; Resource Utilization*

Germany is famous for its industries; and its products have become a symbol of high quality and standards. All these stem from German's attention to engineering education. German advanced engineering education system has distinct characteristics to produce mature engineers as a goal, embodying a complete education system. Meanwhile, Chinese advanced engineering education and continuing engineering education have been developing very fast in recent years, and have been initiated to meet the demand of the market economy. However, comparatively speaking, Chinese advanced engineering education still holds some misconceptions. The practical abilities of engineering trainees are still weak; training system still lacks gradient levels; the core of engineering education is still somehow lost; and due to the limitation of its guidance policy, management system and resource, continuing education still does not play an ideal role of supplementing new knowledge and technology. In our opinions, the shortage of practice teaching resource, as one of the main factors, bottlenecks the development of Chinese advanced engineering education and continuing engineering education.

Several misconceptions in the development of advanced engineering education in China

1. Loss of engineering education characteristics

As we know, the core of engineering education is practice teaching. Nowadays, some Chinese engineering colleges are seeking the university form of being “key” and “comprehensive” rather than educating qualified engineers. It is often the case that colleges’ education focuses more on theoretical knowledge than on practical ability, which can not meet the social demand of pluralism and diversity. In some extent, engineering education and social demand of practice are separated; and practice teaching becomes merely subject teaching. On the other hand, the state’s evaluation system for engineering colleges is not yet perfect and does not put practice teaching as the main criteria, which means the lack of targets. In the meantime, some colleges do not let engineering practice teaching to be involved in the system of evaluation and promotion. Therefore, engineering colleges’ education has strayed from the core and demand of engineering education, which results in the loss of education characteristics.

2. Bias between the scale and quality of education and the social needs

According to the statistics, in 1998 the number of college students reached 3.4 million, of which 1.35 million are engineering students; and in 2005 the total number has become 23 million and the number of engineering students is 5.33 million. Seemingly, the scale of advanced education has boomed 5.7 times in the past few years while engineering students has increased 2.9 times [1]. The above data indicate that despite China's rapid development of advanced education, the rate of engineering education growth is apparently lower than the average.

Currently, with the speeding of China's industrialization and innovations, the demand for engineers and technicians has dramatically increased, particularly in mechanical instruments, electrical electronics, energy power, civil engineering, and many other large-scale application of innovative technology. Moreover, industries are eager for skilled technicians in the production line. However, because some of Chinese engineering colleges can not guarantee engineering practice conditions, the students lack hands-on experience. Engineering education is short of not only quantity but also quality. On the one hand, the society demands all kinds of engineers and technicians; but many engineering college graduates are confronted with unemployment due to their weak practical ability. As a matter of fact, the structural bias between the scale and quality of engineering education and the social needs has been formed.

3. Shortage of engineering practice teaching resource

Ability weakness of students through advanced engineering education has become a common characteristic of many engineering colleges, mainly because engineering education lacks practice resource. The number of laboratories can not fully meet the needs

of practice teaching, and the cooperation of schools and enterprises has not formed an effective mechanism. Since engineering education has inherent characteristics of practice teaching, it needs huge quantities of investment. However, due to the general funding shortage in advanced education, most colleges are not able to invest limited money into a practice teaching base which has the long construction time, high cost and lagged benefits. Thus, they normally do not plan to build laboratory facilities the same time when they are building a new campus. Facing the explosively increasing number of college students, advance engineering education seems to be shorter and shorter of practice resource for students, which directly affects the education quality.

Advantages of Internet-based experiment system in continuing engineering education

With the fast development of China's industrialization, the demand for various types of engineers and technicians is rapidly increasing. General advanced engineering education and continuing engineering education are the two main struts to train engineering students. Under the existing educating system, the growth of engineers and technicians can not evade from the trace of theory learning, practice training and follow-up professional development. Therefore, only through continuing engineering education after graduation can one professionally develop faster and turn to high-quality engineers and technicians.

Continuing engineering education focuses on learning new knowledge and new skills. For technicians with some theoretical basis and initial professional ability, the development of Internet-based experiment system can effectively resolve the problems of practice resources in continuing engineering education. Below are the main three advantages:

1. It breaks through the time and space limit of practice education

The emergence and application of Internet breaks through the concept of time and space. Depending on this, Zhejiang University has successfully developed Internet-based electrical and electronic experiment system to provide a new way for developing laboratory resource in continuing engineering education. Although Internet-based experimental system development has been introduced to various universities, most of the projects only stay in a single-experiment or simulation level, where it lacks systematicness and authenticity. Zhejiang University's system has obvious many advantages that it applies real experimental instruments together with virtual reality technology to greatly enrich the experiment content [2]. When students remotely operate in the client terminals, they are actually processing real experiment through Internet. This can let them feel as if in the lab. Conventional experiment methods have limitations of venues, instruments, time, etc.; however, Internet-based experiment system changes the previous user-present mode and adds more interactive requirements in practice teaching. The development of the system not only provides a new experiment environment for full-time undergraduate and postgraduate education, but also tackles the time and space limitation in continuing engineering education, providing them unprecedented practice experience. Currently, more

than 2000 distance education students in the major of Electrical Engineering and Automation benefit from the system to complete their remote practice training, not to mention full-time undergraduate and graduate students at Zhejiang University.

2. It meets the requirements of open practice teaching in continuing engineering education

The advantages of Zhejiang University's Internet-based experiment system also lie in meeting the requirements of open practice teaching. The system is designed to provide both the synchronous mode and the asynchronous mode; and it satisfies the quantity requirement of simultaneous online trainees, who can book experiments through automatic server. When in the synchronous mode, upon getting permission and controller-user connection, students can interact with instruments and feel the real environment [2]. And if users do not get the result in time they can do it over and over again. Besides, the asynchronous mode is designed to provide convenience to the students who do not have regular log-in time. Because in this mode, user interface and controller terminal are not directly connected. Users design the whole experiment procedure ahead of the real experiment, which is carried out by the control terminal without users' interaction. Then the server sends back the result when the users login at the next time [2]. The two modes greatly facilitate different users' needs in time domain, and let them to receive and process information in more interactive and nonlinear way. Therefore, Internet-based experiment system meets the requirements of open practice teaching in continuing engineering education.

3. It promotes resource sharing in continuing engineering education

Integrated practice teaching resource efficiency is magnified with the breakthrough in the time and space limits. Apart from all the characteristics of virtual laboratories, Zhejiang University's internet-based experiment system also has a simple framework and a wide experiment range. Currently the system includes five experiment categories, namely, control, electrical circuit, electrical machine, power electronics and micro-processor, and over 80 specific sub-experiments [2]. The system can support more and more online users because more and more modules are being placed in the experiment framework. The development of Internet-based experiment system continues to expand practice resource and will eventually achieve the goal of sharing practice teaching resource in continuing engineering education.

Increasing the development intensity of Internet-based experimental system to provide basic conditions for continuing engineering education

In China's current condition that engineering education is short of practice resource and colleges and enterprises have not formed an effective mechanism. Zhejiang University's Internet-based experiment system fully taps virtual instruments, Internet computer real-time control, etc., and tackles the problem of high cost, rapid instrument

updates and instrument wastage. At present the system is the only one used as an open experiment system in Internet-based distance education. The success of the system development demonstrates that it can be feasibly expanded into other fields as well.

The R & D of Internet-based experiment system is a systematic project with high scientific and technological content, which calls for massive academic researchers, Internet developers and software developers with certain backgrounds and skills; and it also requires a large amount of funds. Thus, every aspect should be integrated. The state should grant policy to support and take some measures to make it sustainable.

The state should establish special engineering education investment mechanism and focus on the long term goal. In the implementation of updating engineers' and technicians' knowledge, individual projects are supposed to be set up. With adequate funding, according to the status of Chinese advanced engineering education and the demand for continuing engineering education, we can use modern information technology to systematically develop Internet-based experiment system. At the same time, we should establish a promotion and evaluation system on the R&D, and encourage colleges, institutes and large high-tech enterprises to be involved in the R&D. The government administrative departments should at all levels play a leading role in joining key national research institutes and colleges, large enterprises and high-tech ones, and integrating technology, funds and labor resource. Only in this way can the state improve the cooperation of colleges and enterprises, and promote integrated utilization of Internet-based experiment system.

Recently, Chinese Ministry of Science and Technology has made a plan to invest nearly 60 million RMB into the development of " Key technology research and application of virtual experiment teaching environment " project. It will extend the application range of Internet-based experiment system through the national public service system and TVU online distance education platform. It can be foreseen that the development and application of Internet-based experiment system in various professional fields will provide an important basis for China to rapidly develop promising continuing engineering education.

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Curriculum Vitae

Zheng Yanfen: Director and Research Associate, Office of Degree Programs, Administration of Continuing Education，Zhejiang University

Yuan Fang: Vice Director, Administration of Continuing Education Zhejiang University

Zhu Shanan: Director and Professor, Administration of Continuing Education , Zhejiang University